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Vaccine preferences and acceptance of older adults

R. Eilers [a,b,*], H.E. de Melker [b], J. Veldwijk [c,d], P.F.M. Krabbe [a]

[a] University of Groningen, University Medical Center Groningen, Department of Epidemiology, P.O. Box 30.001, 9700 RB Groningen, The Netherlands
[b] Center for Infectious Disease Control, National Institute for Public Health and the Environment (RIVM), P.O. Box 1, 3720 BA Bilthoven, The Netherlands
[c] Centre for Nutrition, Prevention and Health Services, National Institute for Public Health and the Environment (RIVM), P.O. Box 1, 3720 BA Bilthoven, The Netherlands
[d] Centre for Research Ethics and Bioethics, Uppsala University, PO Box 564, SE-751 22 Uppsala, Sweden

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ABSTRACT

Background: Expanding vaccination programs for the older population might be important as older adults are becoming a larger proportion of the general population. The aim of this study is to determine the relative importance of vaccine and disease specific characteristics and acceptance for Dutch older adults, including pneumococcal disease, herpes zoster, pertussis vaccination, and influenza vaccination.
Methods: A discrete choice experiment was conducted to generate choice data that was analyzed using a mixed multinomial logit statistical model.
Results: Important factors that were associated with vaccination acceptance in older adults are high mortality risk of the infectious disease, high susceptibility of getting the infectious disease, and high vaccine effectiveness. Age, influenza vaccination in 2013 and self-perceived health score were identified as personal factors that affect vaccine preference. Potential vaccination rates of older adults were estimated at 68.1% for pneumococcal vaccination, 58.1% for herpes zoster vaccination, 53.9% for pertussis vaccination and 54.3% for influenza vaccination. For persons aged 50–65, potential vaccination rates were estimated at 58.1% for pneumococcal vaccination, 49.5% for herpes zoster vaccination, 43.9% for pertussis vaccination and 42.2% for influenza vaccination. For persons aged 65 and older, these were respectively 76.2%, 67.5%, 57.5% and 65.5%.
Discussion: Our results suggest that older adults are most likely to accept pneumococcal vaccination of the four vaccines. Information provision accompanied with the implementation of a new vaccine has to be tailored for the individual and the vaccine it concerns. Special attention is needed to ensure high uptake among persons aged 50–65 years.

1. Introduction

Routine childhood vaccination has shown to be one of the most successful strategies to reduce the burden of infectious diseases [1]. For the older adult population (aged 50 years and older), in many countries currently only influenza vaccination is common to prevent disease burden. In the Netherlands, influenza vaccination is offered to all persons aged 60 years and older. Nevertheless, other vaccinations such as pneumococcal, herpes zoster and pertussis vaccinations are available and licensed [2]. Expanding vaccination programs for the older population might be important as older adults are becoming a larger proportion of the general population. Where transmission of infectious diseases in care facilities for the aged are already high, community dwelling older adults will be more socially engaged, which increases the transmission chance of infectious diseases towards this population [3,4]. As a result, prevalences of infectious diseases could rise increasing healthcare demands. Vaccination may yield both individual health benefits (not becoming sick) as well as societal benefits (i.e., lower healthcare demands and costs) as demonstrated by childhood vaccinations [1]. One of the most important factors for any vaccination program to be successful, is the acceptance of such a measure. Various factors such as vaccine and disease specific characteristics and personal factors have been identified that play an important role in the individual decision making process to accept vaccination of persons aged 50 years and older [5,6]. Yet, the relative importance of these identified factors is largely unknown. Obbtaining such information is important to optimize the implementation of vaccines and education programs for health professionals.

Therefore, the aim of this study is to reveal the relative importance of vaccine- and- disease specific characteristics that play a

* Corresponding author at: Center for Infectious Disease Control, National Institute for Public Health and the Environment (RIVM), P.O. Box 1, 3720 BA Bilthoven, The Netherlands.

E-mail address: renske.eilers@rivm.nl (R. Eilers).

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role in the individual decision-making process and final acceptance of four (candidate) vaccines (pneumococcal disease, herpes zoster, pertussis vaccination, and influenza vaccination) among Dutch persons aged 50 years and older. For that purpose, we performed a discrete choice analysis to identify vaccine preferences in this population

2. Methods

2.1. Discrete choice experiment

The term discrete choice experiment (DCE) refers to an experiment that is constructed to collect stated preference data (choices made by individuals under experimental conditions) from survey responses to hypothetical, but realistic scenario's [7]. Using this method in the field of healthcare assumes that healthcare interventions, services, or policies can be described by their characteristics (or attributes). DCE scenarios are characterized by specific attributes (characteristics) of which each attribute is varied by a specified range of categories, called levels. Scenarios are constructed from a combination of these levels. One choice task is comprised of at least two different scenarios. It is assumed that within one choice task, individuals choose the scenario they prefer most. Each respondent receives multiple choice tasks [8]. The data from the DCE is used to estimate the relative importance of the attributes and their associated levels by applying linked statistical modelling [9].

2.2. Selection of attributes and levels

Based on a literature review [5] and a focus group study [10], the following attributes were included in the DCE: clinical symptoms, susceptibility, mortality rate, vaccine effectiveness, side-effects and number of vaccinations. Levels were formulated based on information derived from the focus groups and the specific available clinical disease and vaccine information of pneumococcal, herpes zoster, influenza and pertussis. This resulted in realistic scenarios suitable for the study population.

Table 1 shows the assigned levels to the six attributes in the choice experiment.

Unlabelled scenarios (not explicitly mentioning the type of vaccine or disease on top of each of the two scenarios) were chosen to reduce possible insensitive responses (no trading between attributes) as people may focus disproportionally much on the labels [15].

An opt-out option (indicating no vaccination) was added as vaccination is not obligated in the Netherlands in real life. The attributes in which risks were included were dichotomised as much as possible. In addition, risks were presented in both text (as a risk label) and pie charts to make the interpretation as easy as possible [16,17] (Fig. 1).

2.3. DCE design

The choice tasks were generated by running a D-efficient design (Ngene Software version 1.1.1, http://www.choice-metrics.com). Such a design takes into account prior knowledge concerning the respondent's preferences and limits the generation of dominant scenarios (an obvious preferred scenario). Therefore, small (0.01) positive and negative priors were included in building the design to account for prior knowledge, these were the same for all level across all attributes.

Based on this procedure, the final design consisted of 36 choice tasks which were divided over six blocks of 6 choice tasks (by NGene). The attribute levels varied across all choice tasks. The number of choice tasks was set on six to reduce the cognitive burden on the respondents. Each choice task was introduced with the question: 'Imagine that these two vaccines were offered to you for vaccination; which vaccine do you prefer?'. The initial survey was pilot tested to ensure correct wording and to test whether respondents understood the provided information as well as the choice tasks of the DCE. Think out loud testing (a respondent completes the survey, reading it out loud, in the presence of the researcher) with eight persons ranging in age from 52 to 82 was used as part of the pilot test.

Table 1
The attributes and associated levels for the 4 diseases included in the discrete choice experiment.

Attribute	Levels	Associated disease[a]
Clinical symptoms	The vaccine protects against pertussis characterized by 1 to 3 months of coughing, episodes with tightness of the chest and sleep deprivation [1]	Pertussis
	The vaccine protects against shingles, characterized by 2 weeks of itching and painful skin rash that could develop into chronic pain [2]	Herpes Zoster
	The vaccine protects against pneumonia, characterized by 2 weeks of coughing, tightness of the chest and fever [3]	Pneumococcal disease
	The vaccine protects against the flu, characterized by up to 1 week of high fever, muscle ache and shivers [4]	Influenza
Susceptibility	1 out of 100 persons get the disease [1]	Pertussis
	Half of the people get the disease [2]	Pneumococcal disease, influenza
	Everyone gets the disease [3]	Herpes Zoster
Mortality	1 out of 100 persons with this disease dies [1]	Pertussis, herpes zoster, influenza
	20 out of 100 persons with this disease die [2]	Pneumococcal disease
Vaccine effectiveness	Half of the people are protected by the vaccine [1]	Pneumococcal disease, herpes zoster, influenza
	Everyone is protected by the vaccine [2]	Pertussis
Side effects	The injection site is painful and swollen for 1 day [1]	Pneumococcal disease, herpes zoster, pertussis, influenza
	Not feeling well for a few days which requires to stay home [2]	
Number of given vaccinations	The vaccine has to be given once [1]	Pneumococcal disease, herpes zoster, pertussis, influenza
	The vaccine has to be given twice [2]	

[a] Information on herpes zoster was obtained from [2,11], information on pneumococcal disease was obtained from [2,12], information on pertussis was obtained from [2,11] and information on influenza was obtained from [13,14].

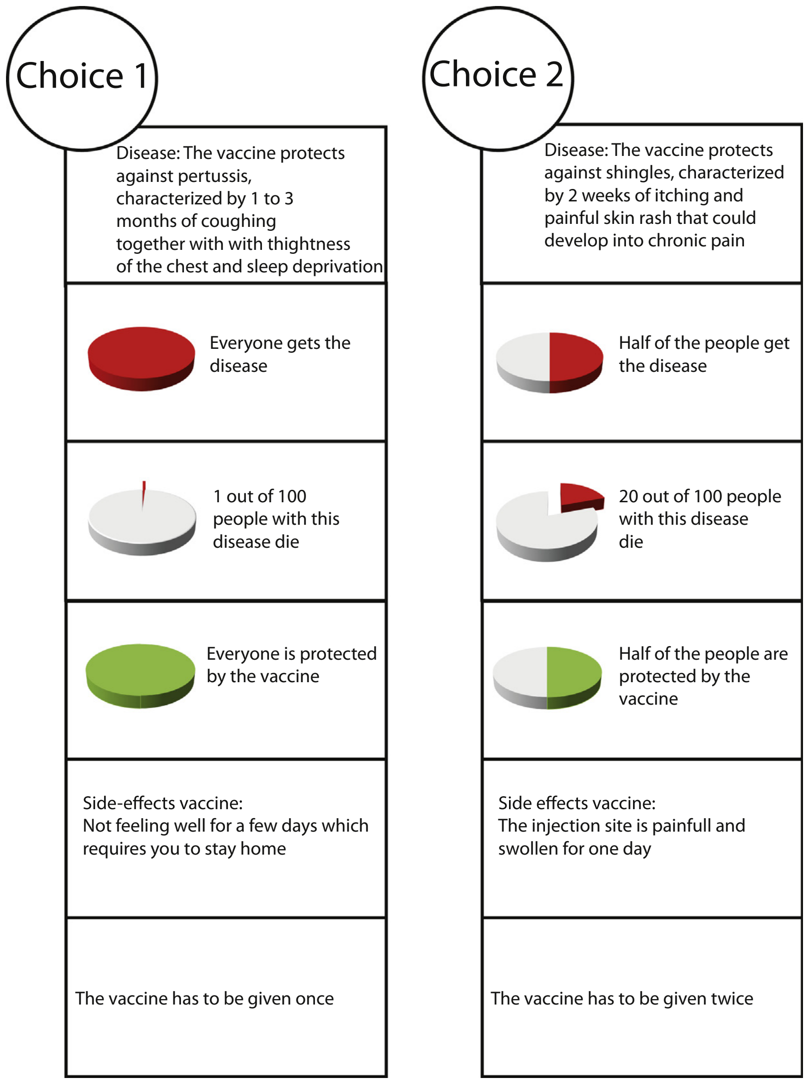

Fig. 1. Example of two scenarios from which respondents had to choose the preferred one.

2.4. Demographics

After the choice tasks, demographics and other personal factors were collected. These included standard aspects such as age, sex, education and questions on the lifestyle and social context of the participants. Current health was assessed with the EQ-VAS health state scale indicator of the EQ-5D [18]. Health literacy scores were gathered by using the Set Brief of Screening Questions [19]. This set comprises of three questions assessing the problems understanding health (care) related information, filling out medical forms and finding health related information. Health literacy level was calculated on the answers given to these three questions [20]. A 'healthy living' variable was also constructed combing non-smoking with $\geq$1 time exercise in the week.

2.5. Respondents

Six municipalities were asked to take a random sample of their population based on four age categories: 50–60 years, 60–70 years, 70–80 years and 80 years and older. We choose to set the age limit to 50 years because vaccinating at that age might have biological advantages (i.e., before the onset of immunosenescence (the gradual deterioration of the immune function). The municipalities were selected based on the urbanisation level and their geographical location. In total, 1800 potential respondents were selected. A postal survey was sent during December 2014. After three weeks, a reminder was sent to the non-responders. Persons returning the survey received a gift voucher of 10 euro. Each survey was accompanied with an invitation letter, giving information about the study, explaining the purpose of the study and contact information if there were any questions.

2.6. Discrete choice analysis

Respondents were excluded if one or more of the choice tasks were not filled in (i.e., more than 10% missing values). Nlogit (version 5, http://www.limdep.com/) was used for choice modelling and SAS version 9.3 (http://www.sas.com) for the preparation of the data, including for example data cleaning, creating age groups and health literacy scores.

Data were analyzed using a mixed multinomial logit statistical model. This model takes into account possible preference heterogeneity and adjusts for the multilevel structure (one respondent makes more than one choice) of the data. The aim of this analysis was to estimate the relative importance of the attributes using the following formula:

$$V_{im} = \beta_1 * \text{clinical symptoms pertussis} + \beta_2 * \text{clinical symptoms herpes zoster} + \beta_3 * \text{clinical symptoms pneumonia} + \beta_4 * \text{mortality } 20\% + \beta_5 * \text{susceptibility } 50\% + \beta_6 * \text{susceptibility } 100\% + \beta_7 * \text{vaccine effectiveness } 100\% + \beta_8 * \text{side effects severe} + \beta_9 * \text{vaccinating twice}$$

$$V_{opt-out} = \beta_0$$

The statistical model estimates the observed utility or 'V_{im}' (the sum of all coefficients), that is the utility an individual (*i*) derives from choosing an alternative (*m*) (or vaccine in this study) for each choice task. The opt-out formula estimates the a priori preference of respondents declining vaccination (i.e., choosing to opt-out) over accepting vaccination.

The sign of the estimates of the attribute (levels) displays if this attribute (level) has a positive or a negative influence on measurable utility. Based on model fit tests (AIC and Chi-square), the constant, clinical symptoms, mortality, susceptibility and effectiveness attributes were included as random parameters. The estimates of these random parameters include a standard deviation (SD) assuming normal distribution. By including random parameters, the model accounts for any heterogeneity in the preference of the respondents concerning those attributes. The presence of preference heterogeneity does not indicate subgroups within a population per se (e.g., heterogeneity for the susceptibility attribute does not automatically mean that older adults with poorer health choose substantially different for all attributes).

Effects coding was used for the attribute levels, which allows estimation of all level effects. [21]. This coding procedure codes the reference category as −1 and the sum of the effect coded attribute levels is always zero. Estimates of the reference category can therefore be calculated as $(\beta_1 + \beta_2 + \beta_n)^* - 1$.

Using the attribute level estimates, the vaccination uptake for different vaccine candidates was estimated using: $1/(1 + \exp^{-V})$ [22].

Because V includes random parameters, the standard deviation of these parameters should be taken into account [8]. This was done by taking 10,000 draws from a normal distribution for each random parameter (i.e., the mean and SD values were retrieved from the mixed logit model). For every draw of the random parameter, the observed utility "*V*" as well as the potential coverage rate was calculated. The average of the 10,000 calculated potential vaccination uptake was reported. A p-value of 0.10 for the levels was considered statistically significant in all analyses.

Separate models were run for persons aged 50–65 years and persons aged 65 years and older in order to compare estimated uptake for influenza with the actual uptake among individuals aged 65 years and older. For future programs expected uptake among 50–65 year olds were of interest. Impact on choice behavior of the different personal factors was assessed by adding each variable as a covariate to the mixed multinomial logit model. Based on literature the variables that were tested were: 'sex', 'education', 'influenza vaccination received in 2013' and 'health score'. Interaction terms were constructed between the attributes and significant personal factors to assess the specific influence of these factors on the attributes.

3. Results

3.1. Study population

In total, 735 surveys were returned (response rate = 41%). Overall, 610 respondents were included in the analysis due to excluding persons with missing data in one (or more) of the DC tasks. Persons aged 60–70 years more often returned the survey and relatively less surveys were received from people aged 80 and older (33% compared to 16% of the respondents). More men than women completed the survey (51.8% vs. 48.2%). Our study population consists of fewer people with the non-Dutch nationality in comparison to the general older adults population (1.3% vs. 3%) [23] and more higher educated older adults (32% vs. 24%) (Statistics Netherlands, 2016]. In addition, self-reported influenza vaccination rate in this study (72.7%) is higher than the actual vaccination rate that year (67.2%) for persons aged 60 years and older [24] (Table 2).

Table 2
The characteristics of the study population (n = 610).

Characteristic	Statistics (%)
Age (M)	67 year
50–60	26.5
60–70	33.0
70–80	24.5
≥80	15.9
Sex	
Women	48.2
Men	51.8
Education[a]	
Low	21.1
Mediate	43.0
High	35.9
Health literacy	
Yes	2.6
No	97.4
Nationality	
The Netherlands	98.7
Non-Netherlands	1.3
Faith	
None	44.9
Rome Catholic	26.1
Protestant	22.8
Other	62.0
Employment[b]	50.8
Healthy living[c]	71.9
Having a partner	78.3
Having a chronic disease	58.4
Asthma or COPD	10.2
Diabetes	8.9
Chronic heart disease	10.7
Rheumatism	17.7
High blood pressure	30.7
Osteoporosis	9.4
Mean health score	78
Insufficient[c]	7.5
Sufficient	32.8
Good	59.6
Internet access	
Yes	87.7
<1 time a day	23.8
1 time a day	25.1
>1 time a day	51.1
Flu vaccination 2013	
Study population	59.8
Persons ≥ 60 years	72.7

[a] Low education: no education or elementary education or prevocational training mediate education: intermediate general secondary education or technical and vocational training or senior general secondary education or pre-university education high education: higher professional education or academic education.
[b] Including voluntary work.
[c] Defined as non-smoking and at minimum exercise once a week.

3.2. Vaccine preferences

In total, 11% of the respondents always choose not to vaccinate (opt-out). Within the total population, respondents preferred a vaccine that protects against an infectious disease with a highest mortality rate, highest susceptibility rate, that is most effective and for which only one vaccination is required. People preferred to be vaccinated against the clinical symptoms of pneumococcal disease over those of influenza and preferred vaccination against the clinical symptoms of influenza over those of pertussis and herpes zoster. Mild side-effects did not affect vaccine decision-making (Table 3).

Both persons aged 50–65 years and persons aged 65 years and older preferred a vaccine against a disease with 20% mortality over 1% mortality, 100% susceptibility rate over 1% and a vaccine with 100% effectiveness over 50% effectiveness. While the number of required vaccinations did affect vaccination preferences among persons aged 65 and older, this attribute was insignificant among the persons aged 50–65. Persons aged 50–65 years preferred vaccination against the clinical syndrome of pertussis over influenza while persons aged 65 years and older significantly preferred influenza vaccination over pertussis vaccination. Both groups preferred vaccination against the clinical syndrome of pneumococcal disease over influenza (Table 3).

3.3. Vaccine preference actors

The variables 'Influenza vaccination received in 2013' and 'Health score' were identified as personal factors that affect vaccine preference. Persons who received the flu vaccination in 2013 reported a higher preference for vaccination against the clinical syndromes of influenza compared to pertussis and herpes zoster compared to persons that did not receive the flu vaccination in 2013.

Persons with a higher self-rated health score attach more importance to a vaccine that protects against an infectious disease with a 20% mortality rate, a vaccine with 100% effectiveness and a vaccine that has to be given twice in comparison to persons with a lower self-reported health score (Table 4).

3.4. Estimated vaccine acceptance

The estimated potential vaccination rates for the different vaccines were calculated for the 50 years and older study population as well as for those aged 50–65 years and those aged 65 years and older (Table 5). The estimated vaccination rate for pneumococcal disease is highest in overall and for the two age groups (68.1%, 58.1%, and 76.2% respectively). For all vaccines, the estimated uptake was lower for persons aged 50–65 compared to persons

Table 3
Estimated coefficients for the complete study population and sub age populations (n = 610).[a]

Attribute levels		Total study population		Population aged 50–65		Population aged 65 and over	
		Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
Constant[b]	Mean	-1.24^{***}	0.23	$-0{,}24$	0.37	-1.83^{***}	0.28
	SD	4.21^{***}	0.28	5.04^{***}	0.50	3.34^{***}	0.30
Clinical syndromes							
Pertussis	Mean	-0.34^{***}	0.09	$0{,}29^{*}$	0.16	-0.65^{***}	0.12
	SD	1.21^{***}	0.13	1.42^{***}	0.21	1.02^{***}	0.16
Herpes Zoster	Mean	-0.15^{*}	0.09	$-0{,}32^{**}$	0.16	-0.06	0.11
	SD	1.19^{***}	0.13	1.58^{***}	0.23	1.07^{***}	0.16
Pneumococcal disease	Mean	0.54^{***}	0.08	0.55^{***}	0.13	0.52^{***}	0.10
	SD	0.64^{***}	0.14	0.80^{***}	0.21	0.65^{***}	0.18
Influenza (ref)	Mean	-0.04	0.11	-0.52^{**}	0.20	0.18^{**}	0.07
	SD	1.81	1.72	2.27	2.20	1.61^{*}	1.51
Mortality							
1% mortality (ref)	Mean	-0.52^{***}	0.06	-0.75^{***}	0.11	-0.38^{***}	0.09
	SD	0.91^{***}	0.08	0.90^{***}	0.13	0.89^{***}	0.11
20% mortality	Mean	0.52^{***}	0.06	0.75^{***}	0.11	0.38^{***}	0.07
	SD	0.91^{***}	0.08	0.90^{***}	0.13	0.89^{***}	0.11
Susceptibility							
1% susceptibility (ref)	Mean	-0.72^{***}	0.08	-1.05^{***}	0.15	-0.53^{***}	0.05
	SD	0.78	0.74	0.92^{*}	0.73	0.92^{**}	0.67
50% susceptibility	Mean	0.07	0.06	0.12	0.12	0.06	0.08
	SD	0.34^{*}	0.13	0.60^{***}	0.20	0.36^{**}	0.15
100% susceptibility	Mean	0.65^{***}	0.07	0.93^{***}	0.13	0.48^{***}	0.09
	SD	0.70^{***}	0.11	0.69^{***}	0.18	0.65^{***}	0.14
Vaccine effectiveness							
50% vaccine effectiveness (ref)	Mean	-0.33^{***}	0.04	-0.40^{***}	0.07	-0.29^{***}	0.05
	SD	0.31^{***}	0.08	0.34^{**}	0.16	0.18	0.13
100% vaccine effectiveness	Mean	0.33^{***}	0.04	0.40^{***}	0.07	0.29^{***}	0.05
	SD	0.31^{***}	0.08	0.34^{**}	0.16	0.18	0.13
Vaccine side-effects							
Mild side-effects (ref)	Mean	0.03	0.04	0.03	0.06	0.05	0.05
Severe side-effects	Mean	-0.03	0.04	-0.03	0.06	-0.05	0.05
Nr. of vaccinations							
Vaccinating once (ref)	Mean	0.07^{**}	0.04	0.03	0.06	0.09^{*}	0.05
Vaccinating twice	Mean	-0.07^{**}	0.04	-0.03	0.06	-0.09^{*}	0.05

[a] Reference levels: Coefficients were calculated by $(\beta_1 + \beta_2 + \beta_n)^* - 1$ for each attribute level.
[b] The coefficient of the constant shows the preference of declining vaccination (choosing to opt-out).
* $P < 0.10$.
** $P < 0.05$.
*** $P < 0.01$.

Table 4
Estimated coefficients for the complete study population including significant vaccine preference actors (n = 610).[a,b]

Attribute levels		Model1		Model 2	
		Coefficient	Std. error	Coefficient	Std. error
Constant[a]	Mean	1.35***	0.28	−4.18***	1.06
	SD	3.72*	0.26	4.07*	0.27
Clinical syndromes					
Pertussis	Mean	0.34**	0.16	−0.35	0.51
	SD	1.13	0.13	1.23	0.13
Herpes Zoster	Mean	0.17**	0.15	0.02	0.47
	SD	1.17	0.12	1.17	0.13
Pneumococcal disease	Mean	0.52***	0.13	0.40	0.40
	SD	0.69	0.14	0.61	0.13
Influenza (ref)	Mean	−1.03	0.20	−0.91	0.20
	SD	1.76	1.64	1.81	1.72
Mortality					
1% mortality (ref)	Mean	−0.56***	0.11	0.37	0.11
	SD	0.91*	0.09	0.87*	0.08
20% mortality	Mean	0.56***	0.10	−0.37	0.29
	SD	0.91*	0.09	0.87*	0.08
Susceptibility					
1% susceptibility (ref)	Mean	−0.93	0.15	0.06	0.15
	SD	0.80*	0.66	0.70	0.62
50% susceptibility	Mean	0.14	0.11	−0.36	0.33
	SD	0.48	0.11	0.36	0.16
100% susceptibility	Mean	0.79***	0.11	0.30	0.36
	SD	0.64	0.11	0.59	0.11
Vaccine effectiveness					
50% vaccine effectiveness (ref)	Mean	−0.38***	0.07	0.08	0.07
	SD	0.29	0.09	0.18	0.16
100% vaccine effectiveness	Mean	0.38***	0.07	−0.08	0.21
	SD	0.29	0.09	0.18	0.16
Vaccine side-effects					
Mild side-effects (ref)	Mean	0.02	0.06	0.02	0.06
Severe side-effects	Mean	−0.02	0.06	−0.02	0.20
Nr. of vaccinations					
Vaccinating once (ref)	Mean	0.03	0.06	0.39**	0.06
Vaccinating twice	Mean	−0.03	0.06	−0.39**	0.20
Interactions					
Health score * mortality				0.01***	0.004
Health score * effectiveness				0.01*	0.003
Health score * nr. of vac.				0.004*	0.003
Prev.vac * pertussis		−0.96***	0.20		
Prev.vac * herpes zoster		−0.47**	0.19		
Prev vac*pneumoccal disease		0.02	0.16		

[a] Model 1 includes the interaction with received previous vaccinations. Only the significant interaction terms are shown.
[b] Model 2 includes the interaction with health score. Only the significant interaction terms are shown.
* $P < 0.10$.
** $P < 0.05$.
*** $P < 0.01$.

Table 5
The value and estimated vaccination rates for the influenza, pneumococcal disease, herpes zoster and pertussis vaccine.

Vaccine[a]	Study population groups		
	50 years and older (n = 610) Estimated vaccination rate (%)	50–65 years (n = 290) Estimated vaccination rate (%)	65 years and older (n = 320) Estimated vaccination rate (%)
Pneumococcal disease	68.1	58.1	76.2
Herpes Zoster	58.1	49.5	67.5
Pertussis	53.9	43.8	57.5
Influenza	54.3	42.2	65.5

[a] See Table 1 for the different vaccine/disease characteristics used to calculate the value.

aged 65 year and older. Pertussis had the lowest estimated uptake of 53.9% for older adults. Looking at the different age groups, for persons aged 50–65, lowest estimate vaccination uptake was estimated for influenza vaccination while for persons aged 65 years and older, lowest vaccination uptake was estimated for pertussis vaccination.

4. Discussion

This experimental study examines the vaccine preferences and vaccine acceptance among Dutch persons aged 50 years and older. Respondents preferred protection against pneumococcal disease over influenza and protection against influenza over pertussis and herpes zoster. Furthermore, high vaccine effectiveness, high mortality and high susceptibility rates were also identified as preferences. Susceptibility rate of an infectious disease seemed to be the most important factor in the vaccination decision-making process of older adults, followed by the clinical syndrome and mortality rate.

Our results suggest that older adults are most likely to accept pneumococcal vaccination from the four available vaccines (influenza, pertussis, herpes zoster and pneumococcal disease), resulting in the highest estimated uptake of 68.1%. For all vaccines, the estimated uptake was lower for persons aged 50–65 compared to persons aged 65 year and older. While for persons aged 65 years and older vaccination uptake for influenza was higher than for pertussis vaccination and similar to that for herpes zoster, little difference in uptake between influenza and pertussis was found for 50–65 year olds with higher uptake for herpes zoster.

Our estimated influenza vaccination uptake of 65.6% among persons aged 65 years and older is in line with the actual uptake of 67% among this population in 2014 [24]. In this age group, also the highest vaccine uptake of the study was estimated for pneumococcal disease with 76.2%.

Although protection against the clinical symptoms of pneumococcal disease seems to a preference by the total study population, preference concerning the clinical symptoms seems to be age-dependent. For persons aged 50–65 years, a vaccine that protects against the clinical symptoms of pertussis is preferred over a vaccine that protects against the clinical symptoms of influenza. This is the opposite for the 65 years and older population. In addition, persons aged 50–65 years prefer a vaccine that protects against the clinical symptoms of influenza over a vaccine that protects against the clinical syndrome of herpes zoster, while the population aged 65 years and over did not report significant preferences for this vaccine compared to influenza vaccination.

Differences in vaccine preferences were also observed between people that received earlier influenza vaccination or not as well as between persons with higher or lower self-perceived health scores. Older adults that perceive themselves as healthier, preferred prevention against diseases with high mortality rates, high vaccine effectiveness and vaccinating twice more compared to older adults with lower health scores do. The preference to receive two vaccinations might seem particular; however, it could be possible that these people feel that they will be better protected with a second vaccination.

Older adults that received the earlier influenza vaccination reported a higher preference for vaccination against the clinical syndromes of influenza compared to pertussis and herpes zoster compared to persons that did not receive earlier influenza vaccination. This seems logical, as older adults that accept vaccination against influenza probably perceive influenza as a serious disease And given that influenza vaccination program is already in place it might be that this vaccine will be preferred because of its familiarity.

In general, the implementation of additional vaccines to achieve the highest possible uptake is challenging. Processes such as immunosenence (the gradual deterioration of the immune function) lead to a biological susceptibility of which people may not be aware. With regard to vaccine effectiveness, immunosenescence poses a challenge as well because it may lead to decreased vaccine effectiveness. Vaccination response might be better when vaccination is offered before this process sets in. However, it has to be acknowledged that the estimated vaccination rates for persons aged 50–65 years were lower, therefore the pros and cons of introducing vaccination at earlier age should be weighed. Also, the possibility of waning immunity has to be kept in mind. Since respondents prefer to be vaccinated if they perceived themselves highly susceptible, it is important to inform the older adults on their biological susceptibility. Given the important role of the general practitioner in the Netherlands as advisor and executioner of the influenza vaccination, they probably are the most appropriate source of information.

Vaccination may yield individual and societal benefits. Aspects such as vaccine effectiveness, disease mortality rate and susceptibility are important to focus on with the vaccine information provision. This may lead to achieving the highest possible uptake and therefore contribute to healthy ageing. Currently, only influenza vaccination is offered to persons aged 60 years and older (and to certain risk groups) in the Netherlands. This vaccination is offered free of charge. In the current study, vaccines were offered to the respondents indicating no costs. It is not clear yet in what way additional vaccines may be implemented at this point so this should be taken into consideration. Still, for any vaccination program to be successful, acceptation is crucial. This study therefore gives insight in the potential success of the implementation of new vaccines.

This study is, to our knowledge, the first DCE study conducted about older adult vaccination. Our results are in line with recent other studies that examine vaccine specific attributes in different Western populations. Studies on children [25–27], parents [28–32] and the general population [33] all show preferences for high vaccine effectiveness. In most studies, respondents significantly preferred minor side-effects or low chance on (severe) side-effects over high levels of side-effects, while in our study, mild side-effects did not affect vaccine decision-making [25,30–32,34]. It could be possible that side-effects following vaccination of children is found to be more important than side-effects following vaccination of adults. Our study results are more similar to the observations of Determann et al. and Hofman et al. who suggest that side-effects compared to other vaccine characteristics are less important when deciding on vaccinations [27,33]. In contrast to the current study, sex and education in fluenced vaccine related preferences in these studies.

4.1. Limitations

Using discrete choice experiments it was possible to indicate the relative importance of the different attributes in the experiments. In addition, we could calculate potential up-take/use of the chosen measure so it can provide input for realistic implementation strategies. Another advantage is that a DCE is always complementary to a regular questionnaire, this way covariates can be included to explain differences in preferences.

However, our study has some limitations. First of all, this DCE was conducted among older adults, while previous research shows that DCEs pose a cognitive burden on participants [8], especially if they are older [35]. To overcome this concern and to ensure that older adults would be able to fill in the choice tasks, extensive pilot testing was incorporated which included think out loud testing and choice tasks were simplified as much as possible. We included, for example, vaccine effectiveness as a two level attribute (100% versus 50%). We therefore assume that respondents were capable to complete the DCE as provided to them. A limiting factor, related to the simplification, may be that no attribute was included that concerns the influence of the advice of a general practitioner. From literature, it is known that the general practitioner plays an important role in the vaccination decision-making of older adults. Further research has to be conducted to identify the relative importance of the general practitioner alongside the disease and vaccine characteristics.

Although the selection of the respondents in our study was carefully planned based on random sampling in specific each category and the response rate was comparable with other DCE studies, there might be selection bias in our study due to the higher number of persons between the age of 60 and 70 years and higher educated people. Their opinions are therefore overrepresented in the choice modelling while there is an underrepresentation of the vaccine preference for the persons aged 80 and older and lower educated persons. This might influence the results because previous research suggests age dependent attitudes towards clinical symptoms and a more critical attitude towards vaccination in relation to a higher educational level [10,36]. However, our estimated influenza vaccination acceptance rate is in line with the actual influenza vaccination acceptance rate, which ensures some validity of the data.

4.2. Conclusion

The prominent factors that influence the vaccination choices of older adults are the vaccine effectiveness, the susceptibility for an infectious disease and the mortality caused by an infectious disease. Pneumococcal vaccination could be the most suitable candidate for implementation since this vaccine has the highest potential vaccine uptake. Moreover, vaccine preferences were associated with age, having received earlier influenza vaccination and the self-perceived health score. These findings need to be taken into account when considering implementation of vaccination in older adults. Therefore, information provision accompanied with the implementation of a new vaccine has to be tailored for the individual and the vaccine it concerns.

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